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THE UNITED STATES OF AMERICA

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August 11, 2005

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APPLICATION NUMBER: 60/583,790

FILING DATE: *June 30, 2004*

RELATED PCT APPLICATION NUMBER: *PCT/US05/23721*



Certified by

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).

Docket Number 254905US8PROV

INVENTOR(s)/APPLICANT(s)

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EDSBERG	David	B.S.	Herndon, Virginia, USA

☐ Additional inventors are named on separately numbered sheets attached hereto.

TITLE OF THE INVENTION (500 CHARACTERS MAX)

RAPID FIRE ACQUISITION

CORRESPONDENCE ADDRESS

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ENCLOSED APPLICATION PARTS

- ☒ Specification *Number of Pages:* 3 ☐ CD(s), Number
☒ Drawing(s) *Number of Sheets:* 1 ☒ Other (specify): White Advance Serial Number Card
☒ Application Data Sheet

METHOD OF PAYMENT

- ☐ Applicant claims small entity status. See 37 CFR 1.27.
☐ A check or money order is enclosed to cover the Provisional Filing Fees
☒ Credit card payment form is attached to cover the Provisional Filing Fees in the amount of \$160.00
☐ The Director is hereby authorized to charge filing fees and credit any overpayment to Deposit Account Number 15-0030

PROVISIONAL \$160.00
FILING FEE
AMOUNT

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

- ☒ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully Submitted,

6/30/09

DATE

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PROVISIONAL APPLICATION FILING ONLY

Rapid Fire Acquisition

Cross Reference to Related Applications

The entire contents of U.S. Patent Application No.10/721,419, attorney docket no. 242845US8, entitled METHOD, APPARATUS, AND SYSTEM FOR CALCULATING AND MAKING A SYNCHRONOUS BURST TIME PLAN IN A COMMUNICATION NETWORK, filed November 26, 2003, is incorporated herein by reference.

Background

The preferred embodiment of this invention is realized in a Star or Star/Mesh topology VSAT satellite network where the network control entity is located at a central hub earth station and customers with remote earth stations are connected to the hub via satellite link.

In the Star and Star/Mesh Topologies, the hub earth station transmits a continuous downstream carrier which is broadcast such that all remotes can receive its transmission. The remote earth stations transmit bursts of data to the hub using TDMA. When a remote is powered on, resets, comes out of a rain fade, or otherwise loses contact with the hub it must reacquire into the network. The process of acquisition involves the remote and hub performing station-keeping operations with the goal of preparing the remote to transmit TDMA bursts such that they can be received reliably without corrupting other users of the TDMA channel or neighboring users on other portions of the satellite or on neighboring satellites.

Conventional acquisition techniques vary from simple to complex depending on the sophistication of the hub receive circuitry and control mechanism. A very simple and commonly used technique is ALOHA access where the remote terminals burst in randomly to the hub receiver and rely on the probability that no other user will access the channel at that instant. In such a system no acquisition algorithm is needed per se; a remote simply powers up and begins to transmit. Collisions between data burst result in data corruption requiring the colliding users to retransmit lost data. Even in an ALOHA system, however, provisions must be made to ensure that the remote's local frequency reference is stable and that its power level is adequate to close the link but not high enough to introduce inter-modulation interference on the satellite transponder. More complex techniques are used for TDMA systems where users are assigned specific slots at a predefined time frame in which to transmit. One common technique is for an earth station to transmit a very short burst (much shorter than its time slot) into its assigned slot. When the hub receives the short bursts, it provides feedback to the remote regarding its symbol timing relative to the frame, its power level, frequency offset, and potentially other station keeping parameters. The remote adjusts the parameters as directed until the hub determines that it is ready to transmit full length traffic bursts in its assigned slot without interfering with any other users. Another technique involves designating a portion of the TDMA frame as an acquisition slot with additional guard symbols to allow remotes to burst in with full sized bursts until the station keeping parameters are adjusted.

There is no problem with ALOHA based acquisition other than the inherent problem with ALOHA networks which is that communication totally breaks down due to an increasing frequency of collisions when the channel use exceeds 18% capacity. Networks seeking to operate at larger capacity at or approaching 100% channel use must use predefined slots and some slot assignment methodology and a corresponding acquisition procedure. The problem with conventional complex acquisition procedures such as the ones described above is that they require multiple "handshakes" back and forth between hub and remote in order to bring all station keeping parameters under control. These handshakes involve waiting for commands and responses to propagate across the long latency satellite channel where the round trip time is as much as half a second. This results in the total acquisition time being directly proportional to latency which introduces a serious scalability problem. Even a very efficient acquisition algorithm may require three round trip times to complete (some implementations require 20 or more) so the total time to acquire a remote would be 1.5 seconds. This means that a network of 1000 remote sites would require 1500 seconds (25 minutes) to fully recover from a network wide reset (less efficient implementations take many hours). This time could be reduced somewhat by adding complexity to the hub controller such that it can handle many messages simultaneously, however the total acquisition time is still proportional to latency.

Summary of the Invention

The preferred embodiment is an acquisition method which is not proportional to latency of the satellite channel. Messages from the hub instructing each individual remote to transmit on a given slot are sent in a pipelined fashion to all remotes without waiting for any of the remotes to respond. Each remote transmits an acquisition burst back to the hub in the slot it was instructed to use. When a burst is received by the hub, it calculates station keeping correction factors and sends them to the remote and immediately declares the remote "in network" such that it is eligible to be assigned traffic slots. Two requirements must be met in order for this algorithm to work: 1) A synchronous burst time plan must be utilized such that remotes can receive instructions to transmit their acquisition burst exactly X frames and Y symbols later. 2) The TDMA time frame must include one or more acquisition slots which have enough additional guard symbols that remotes can transmit a full burst into the desired acquisition slot without the possibility of "missing" the slot and corrupting traffic slots or other acquisition slots.

Three acquisition states exist: Undetected, Detected, and Acquired. Remotes that have lost contact with the hub controller are Undetected and in the case where a network wide restart occurs, all remotes start out Undetected. Detected means that an error free data burst has been received at the hub over the TDMA upstream channel in an acquisition slot as assigned. Acquired means that the hub controller has commanded the remote to correct any offsets in its station keeping parameters and begin transmitting in traffic slots.

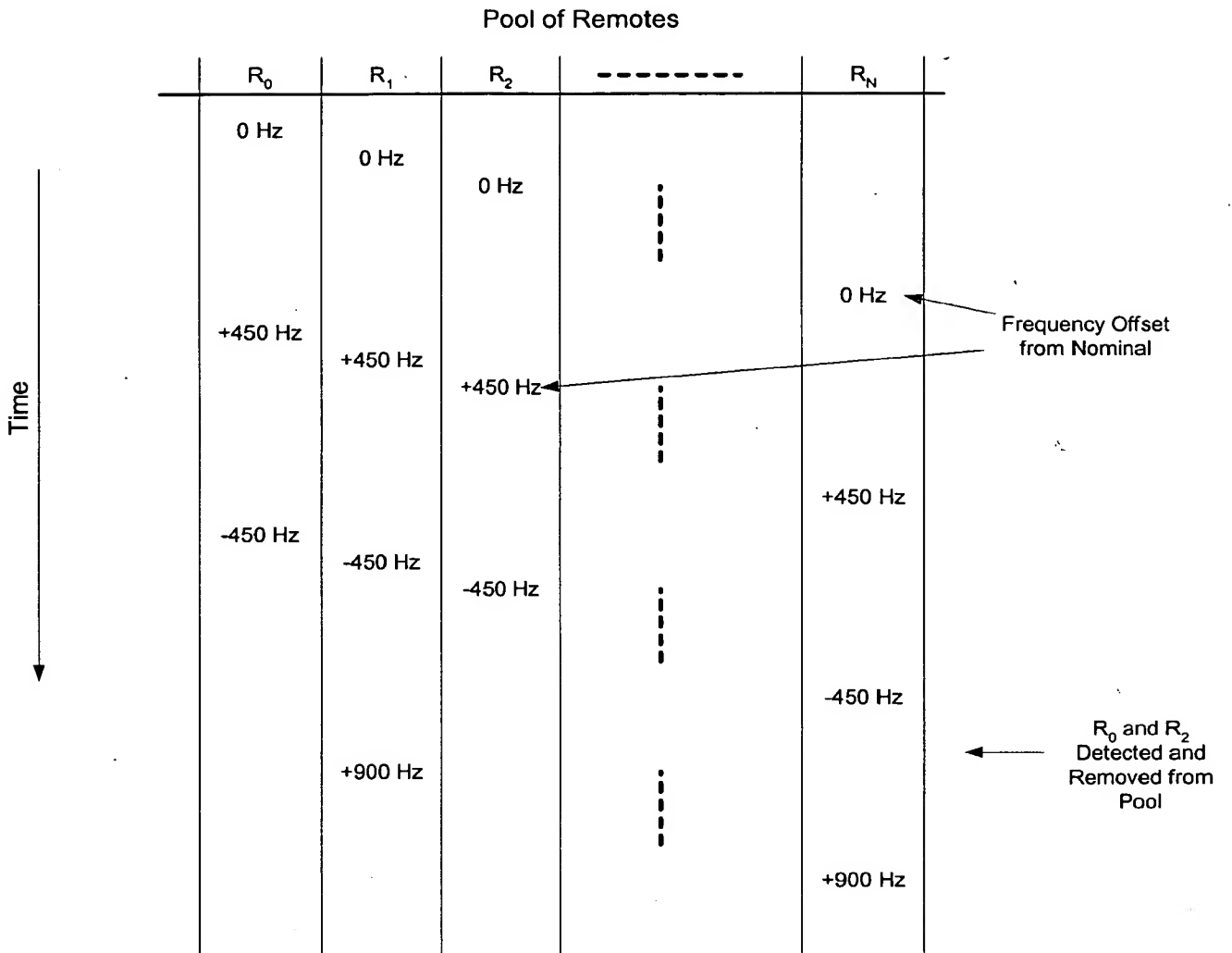
As stated, at a system restart all Remotes are Undetected so they are placed in a pool and the hub controller schedules them to send a burst to the hub on a designated acquisition slot in a round robin fashion. Since all Remotes are synchronized the hub does not have to wait for any response before scheduling more acquisition bursts. Every time all remotes in the pool are commanded to transmit once, the hub controller

repeats the process, this time commanding the Remotes to use a different frequency offset. As successful bursts are received and Remotes are transitioned to the Detected state they are removed from the pool.

There are two optional enhancements that can be added to speed the algorithm further: 1) calculating a common mode frequency offset to limit the amount of sweeping required, and 2) Using multiple acquisition slots per frame.

The first enhancement exploits the fact that the major contributor to frequency offset is the hub receive equipment which is common to all remote-to-hub transmission paths. As remotes begin to be Detected, an average of the frequency offsets is maintained to try and estimate the Common Mode Offset due to hub receive equipment. Once enough remotes have acquired to achieve a good frequency offset estimate, the frequency offsets being sent to all Undetected remotes is adjusted to a new nominal where bursts are most likely to be received rather than systematically covering the whole sweep range.

The second enhancement exploits the fact that during a system wide restart, there is no need to allocate traffic slots in the TDMA frame because all remotes are Undetected. Therefore, multiple acquisition slots may be allocated in a single frame so that the pool of remotes can be serviced more quickly. As remotes begin to acquire, traffic slots are added to the frame and the number of acquisition slots are reduced. Once all remotes have joined the network there is no need for any acquisition slots.



APPLICATION DATA SHEET

APPLICATION INFORMATION

Application Type::	PROVISIONAL
Subject Matter::	UTILITY
CD-ROM or CD-R?::	NONE
Title::	RAPID FIRE ACQUISITION
Attorney Docket Number::	254905US8PROV
Request for Non-Publication?::	YES
Total Drawing Sheets::	1

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